Topic Notes

Overview and Detail + Focus and Context

CS 7450 - Information Visualization
November 6, 2013
John Stasko

Fundamental Problem

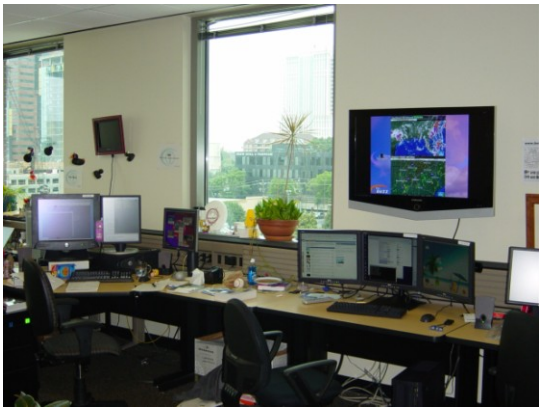
- Scale - Many data sets are too large to visualize on one screen
  - May simply be too many cases
  - May be too many variables
  - May only be able to highlight particular cases or particular variables, but viewer's focus may change from time to time

Large Scale

- One of the fundamental challenges in information visualization
  - How to allow end-user to work with, navigate through, and generally analyze a set of data that is too large to fit in the display
  - Potential solutions lie in
    - Representation
    - Interaction
    - Both

One Solution :^)

You can just buy more pixels



Problem: You'll always eventually run out of pixels

Overview

- Providing an overview of the data set can be extremely valuable
  - Helps present overall patterns
  - Assists user with navigation and search
  - Orients activities
- Generally start with overview
  - Shneiderman mantra

Details

- Viewers also will want to examine details, individual cases and variables
- How to allow user to find and focus on details of interest?
- Generally provide details on demand

Providing Both

- Overview + detail displays can be combined via either time or space
  - Time - Alternate between overview and details sequentially in same place
  - Space - Use different portions of screen to show overview and details
- Each has advantages and problems
- Hybrid approaches exist

Specific Problem

- Develop visualization and interface techniques to show viewers both overview + detail, and allow flexible alternation between each
- Potential Solutions????
  - Discuss….

One Common Solution

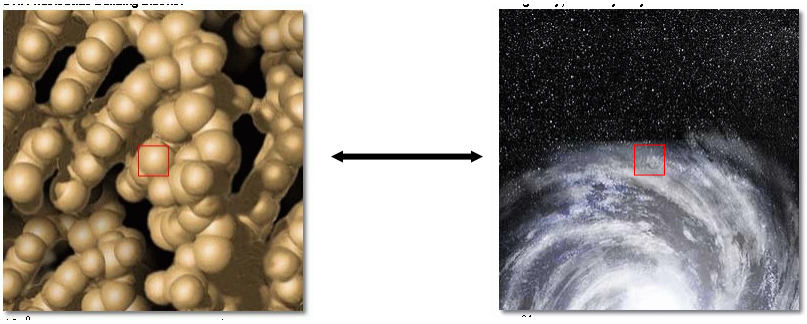
- Pan/Scroll
  - Provide a larger, virtual screen by allowing user to move to different areas
- Still a problem
  - Clunky interaction
  - Only get to see one piece

Another Solution

- Zoom
  - Zoom out shows an overview of data space then zooming in allows viewer to examine details

Zooming

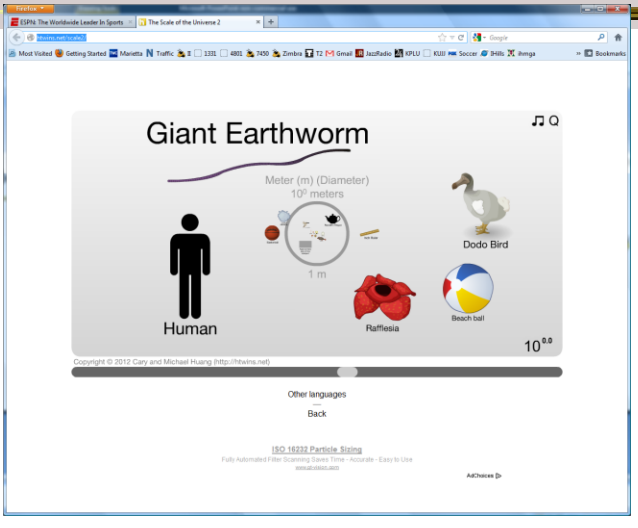
Powers of 10



http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/index.html

Similar Idea

http://htwins.net/scale2/



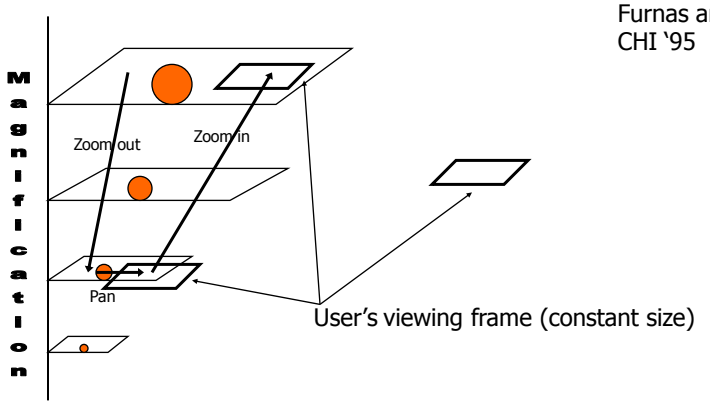
Understanding Zooming

- Introduction of idea of "space scale diagram"
- Characterizes operations in zooming through this new diagram they introduce
- Goals
  - Understand multiscale systems
  - Guide design
  - Authoring tool

Furnas & Bederson
CHI '95

Space-Scale Diagram

Furnas and Bederson
CHI '95



Technique for describing panning and zooming interfaces

Pad -> Pad++ -> Jazz ->Piccolo

- Environments for supporting flexible, smooth zooming and panning on structured graphics world
  - Pad - Perlin & Fox, NYU
  - Pad++ - Bederson & Hollan, Bellcore & New Mexico
  - Jazz - Bederson, Maryland
  - Piccolo, Bederson, Maryland

Toolkit Characteristics

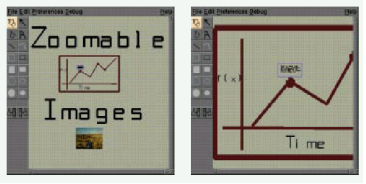
- Support library for building applications
- Infinite plane, panning in x-y, zooming in-out
- 2.5-D, not 3-D
- Important concepts
  - Portals
  - Lenses
  - Sticky objects
  - Semantic zooming

Efficiency Measures

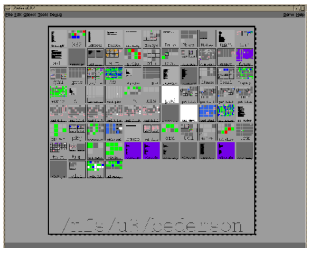
- Level of detail
  - Render items depending on how large they are on screen, don't draw small ones
- Refinement
  - Render fast with low detail while moving, refine image when still
- Region management
  - Only update portion of screen that has been changed
- Interruption
  - User input takes precedence, moves animations to their end state, gets handled

Pad++ Applications

- PadDraw
  - Simple graphics editor

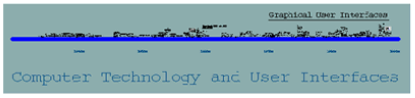


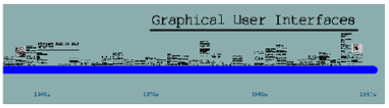
- File/Directory browser

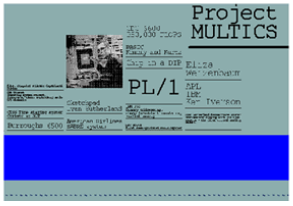


Applications

Timeline views







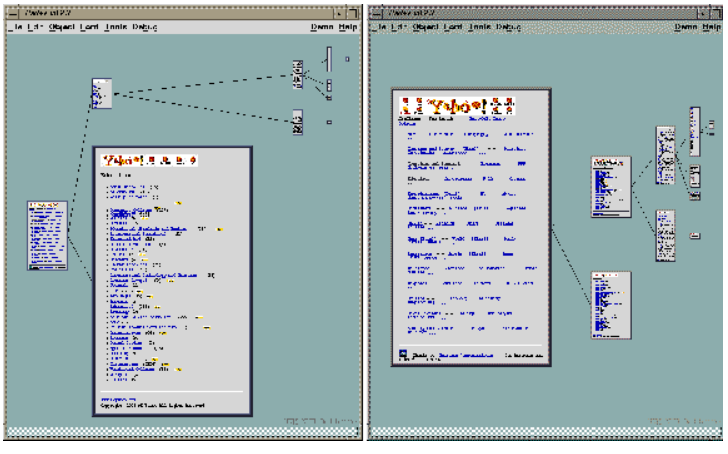
Example: Web History

Web traversal history

PadPrints

Hightower et al UIST '98

Video

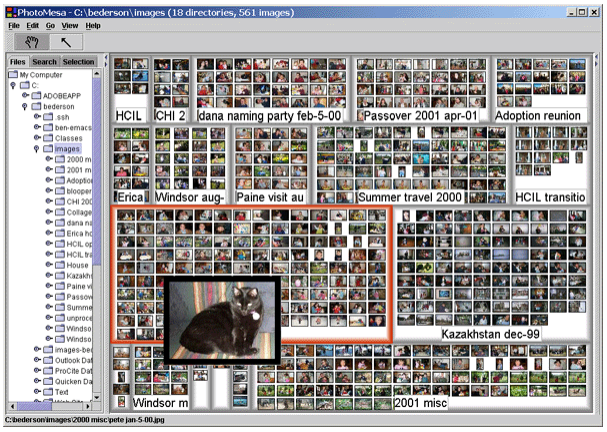


Browsing Images

PhotoMesa

Uses panning and zooming to browse a photo collection

Bederson
UIST `01



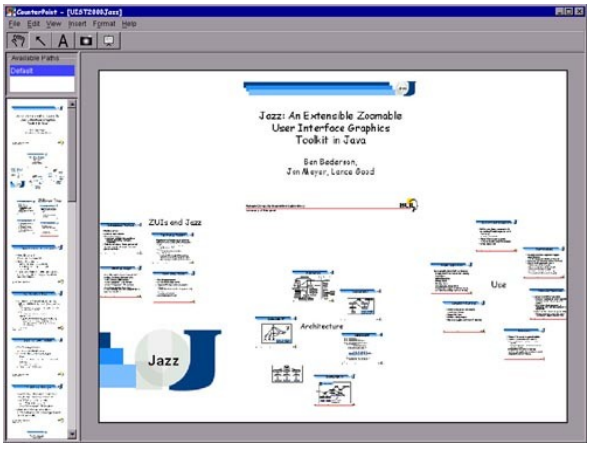
Demo & Video:
www.cs.umd.edu/hcil/photomesa

Presenting Talks

CounterPoint

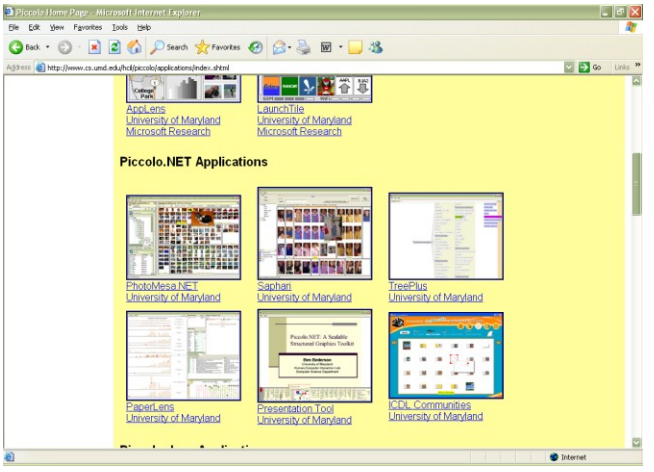
Uses panning and zooming in PowerPoint

Good & Bederson
Information Visualization `02



Demo:
www.cs.umd.edu/hcil/counterpoint

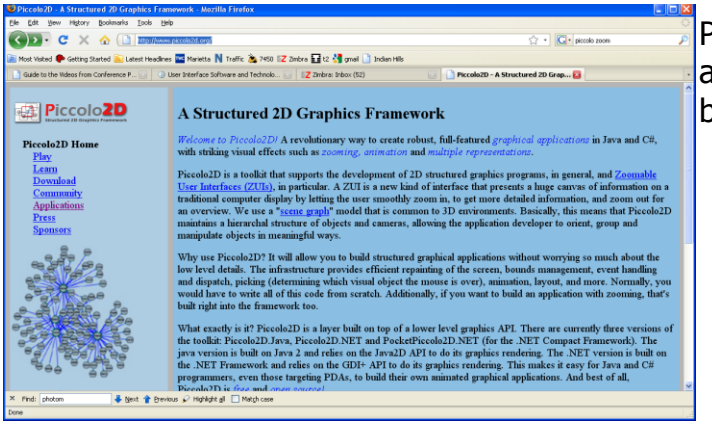
Many More Applications



http://www.cs.umd.edu/hcil/piccolo/applications/index.shtml

Current Status

http://www.piccolo2d.org/



Piccolo has an active user base

Other Systems

- Let's see some other examples…

Wing

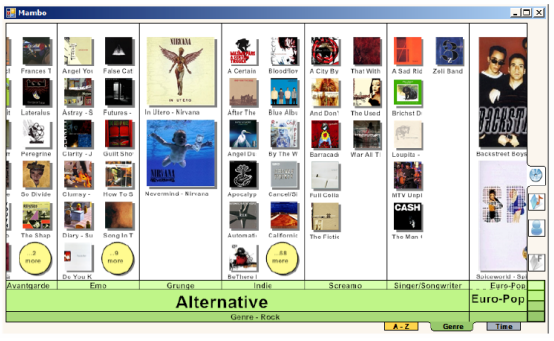
- Another system providing zooming techniques
- Provides zooming on an index or table of contents to see more detail
- Integrated with multi-window overview and detail multimedia tool

Masui, et al
UIST '95

Video

FacetZoom

- Combine (hierarchical) facets with zooming UI for exploration

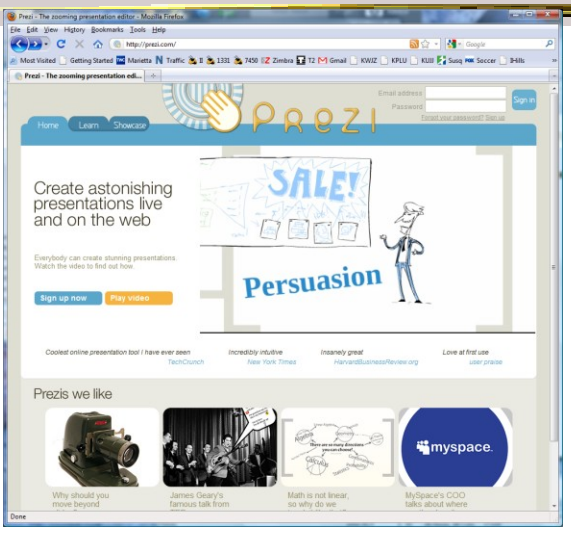


Video

Dachselt et al
CHI '08

Example Application

http://prezi.com



Issues

- Getting lost
  - Zoom in or out way too far
  - Can't see anything

- Termed "Desert fog" by Jul and Furnas

Videos

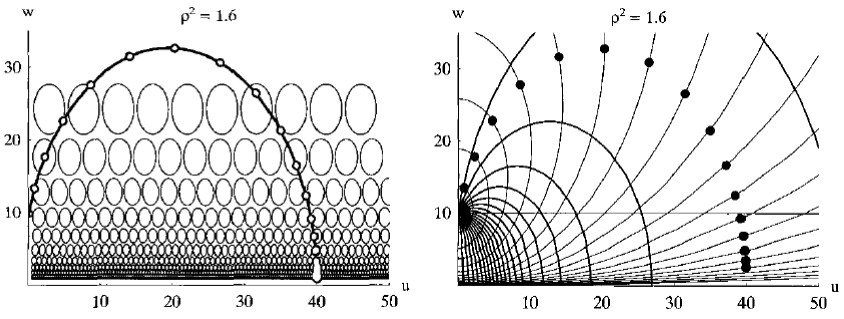
Jul and Furnas, UIST '98

Jul and Furnas, UIST '00

Optimal Actions

- Sometimes, these kinds of UIs can be disorienting to viewer
- Example
  - Long pan isn't any good
  - Better: Zoom out, pan a little, zoom in

Optimal Trajectories



Van Wijk & Nuij
InfoVis '03

Other Alternatives

- Allow viewer to examine cases and/or variables in detail while still maintaining context of those details in the larger whole
- Concession
  - You simply can't show everything at once
- Be flexible, facilitate a variety of user tasks

Nature of Solutions

- Not just clever visualizations
- Navigation & interaction just as important

- Information visualization & navigation

Confound

Devices with even smaller screens are becoming more popular!

An Example

Overview and detail (from *Civilization II* game)

Survey of Techniques

- Application concern: viewing and editing large images
- Expanding the notion of the one dimensional scroll bar: zooming, diagonal panning, multiple detailed views
- List of visualization/interaction solutions…

Plaisant et al
IEEE Software '95

1. Detail-only

- Single window with horizontal and vertical panning
- Works only when zoom factor is relatively small
- Example: Windows

2. Single window with zoom and replace

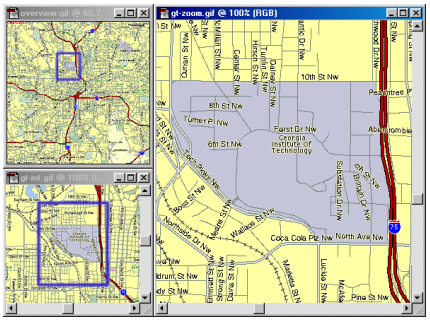
- Global view with selectable zoom area which then becomes entire view
- Variations can let users pan and adjust zoomed area and adjust levels of magnification
- Context switch can be disorienting
- Example: CAD/CAM

3. Single coordinated pair

- Combined display of the overview and local magnified view (separate views)
- Some implementations reserve large space for overview; others for detail
- Issue: How big are different views and where do they go?

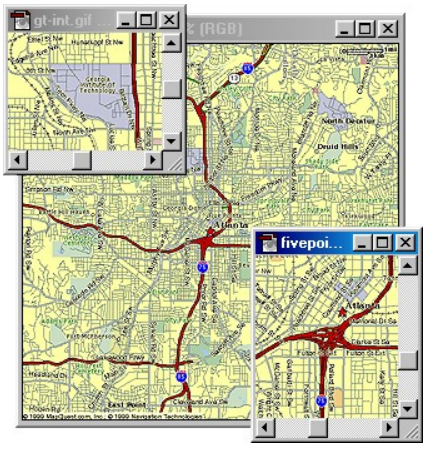
4. Tiled multilevel browser

- Combined global, intermediate, and detail views
- Views do not overlap
- Good implementations closely relate the views, allowing panning in one view to affect others



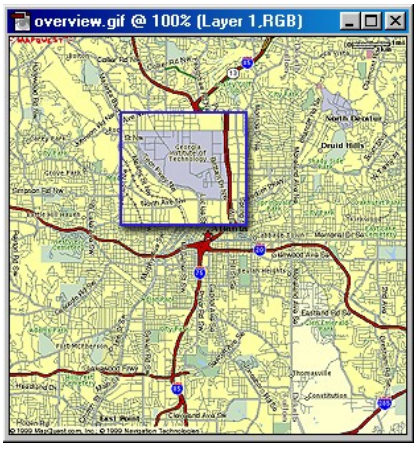
5. Free zoom and multiple overlap

- Overview presented first; user selects area to zoom and area in which to create detailed view
- Flexible layout, but users must perform manual window management



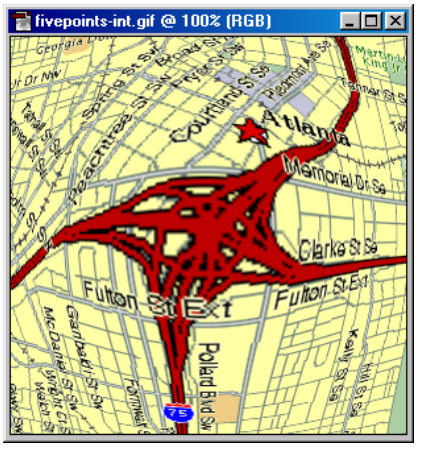
6. Bifocal magnified

- "Magnifying glass" zoomed image floats over overview image
- Neighboring objects are obscured by the zoomed window



7. Fish-eye view

- Magnified image is distorted so that focus is at high magnification, periphery at low
- All in one view
- Distortion can be disorienting
- More details coming...

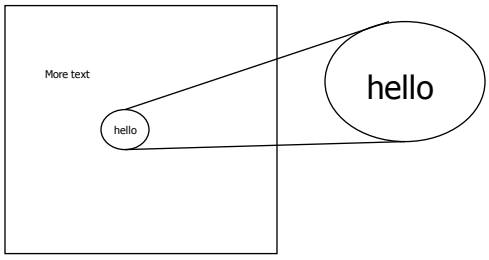


Examples

- Let's look at some specific techniques…

Magnifier Problem Fix

DragMag Image Magnifier



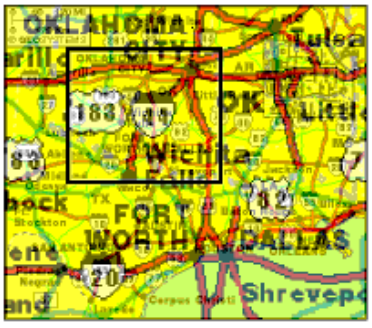
Bifocal magnified display without problem of obscuring the neighboring items

Video

Ware and Lewis
CHI '95

Transparent Overlays

Make detailed view semi-transparent, then overlay overview with it



May even control transparency of each

Lieberman
UIST '94

Important Issue

- The "overview" display may need to present huge number of data elements
- What if there simply isn't enough room?
  - The number of data elements is larger than the number of pixels
  - (Recall Table Lens question?)
- Approaches?

Two Main Approaches

- 0. Interactive display (add scrolling)
  - Is it still an overview?
- 1. Reduce the data
  - Eliminate data elements
    But then is it still an overview?
  - Aggregate data elements
- 2. Reduce the visual representation
  - Smart ways to draw large numbers of data elements

Drawing the Overview

Information Mural

What do you do when your data set is too large for your overview window?
--- More data points than pixels
--- Don't want to fall back on scrolling

Jerding and Stasko
InfoVis '95, IEEE *TVCG* '98

Information Mural

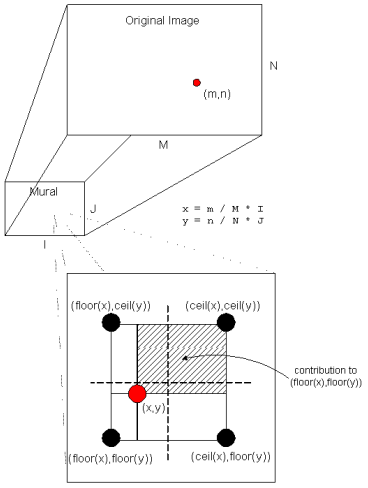
Use techniques of computer graphics (shading and antialiasing) to more carefully draw overview displays of large data sets

Think of each data point as ink and each screen pixel as a bin

Data points (ink) don't fit cleanly into one bin, some ink may go into neighboring bins

Can map density to gray or color scale

Mural Algorithm

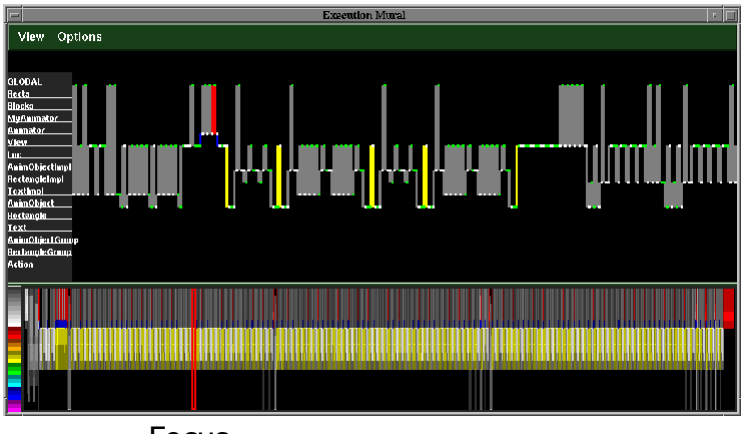


Mural Example

Object-oriented code executions

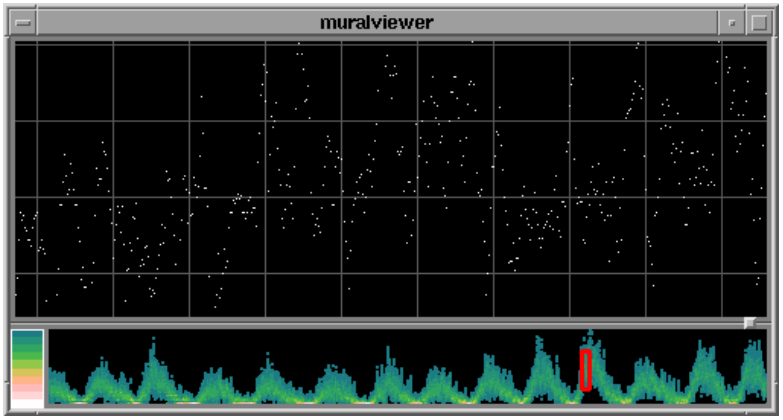
Detail

Overview



Focus

Mural Example

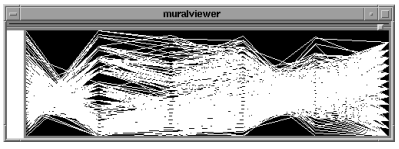


Sunspot activity over 150 years

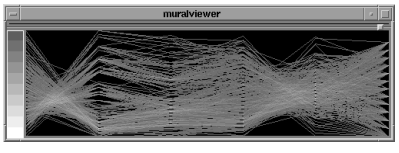
Mural Example

Parallel Coordinates

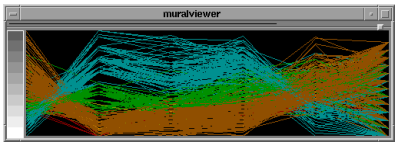
normal



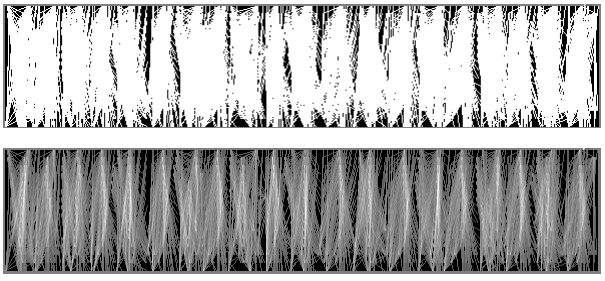
muralized



colorized

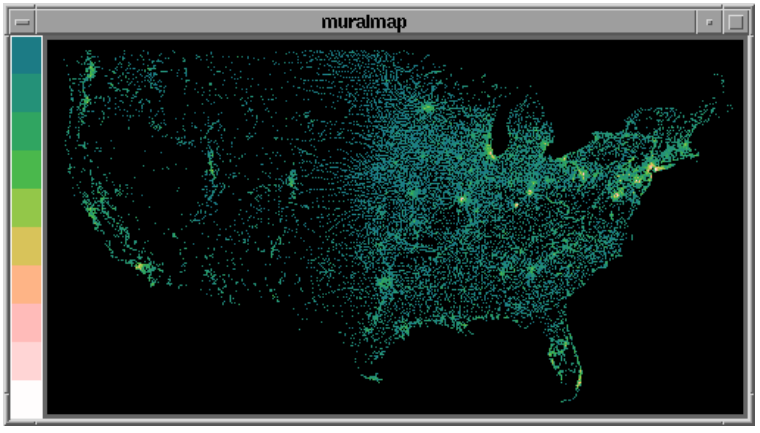


Mural Example



Message passing in parallel program

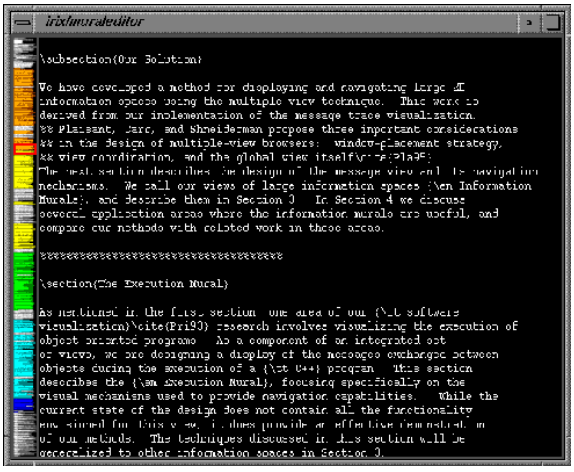
Mural Example



U.S. Census Data

Mural Example

LaTeX source file



Video

Multiple Windows/Views

- Fundamentally, (good) overview & detail involves multiple views
- When should you use multiple views?
- What makes a good multiple view system?

Using Multiple Views

- We've seen many, many examples throughout the class so far
- What makes for an effective multiple view system?

Baldonado, Woodruff and Kuchinsky
AVI '00

Some important ideas

- Views can differ in their data or the representation of that data
- Design tradeoffs between cognitive aspects and system requirements
- Multiple views can decrease utility if not implemented correctly
- Three dimensions: selection, interaction and presentation of views

8 Guidelines

- Rule of Diversity: Use multiple views when there is a diversity of attributes
- Rule of Complementarity: Multiple views should bring out correlations and/or disparities
- Rule of Decomposition: "Divide and conquer". Help users visualize relevant chunks of complex data

8 Guidelines

- Rule of Parsimony: Use multiple views minimally
- Rule of Space/Time Resource Optimization: Balance spatial and temporal benefits of presenting and using the views
- Rule of self Evidence: Use cues to make relationships apparent.

8 Guidelines

- Rule of Consistency: Keep views and state of multiple views consistent
- Rule of Attention Management: Use perceptual techniques to focus user attention

Challenge

- Have context/overview seamlessly and smoothly co-exist with focus/detail
- Why?
  - Easier to move between the two, helps assimilate view updates, less jarring, …
- Not all overview and detail techniques are good at this

Focus + Context Views

- Same idea as overview and detail, with one key difference:
  - Typically, the overview and the detail are combined into a single display
  - Mimics our natural vision systems more closely

How?

- What techniques have we seen so far that would help accomplish focus+context?

Possible Methods

- Filtering
- Selective aggregation
- Micro-macro readings
- Highlighting
- Distortion

Prototypical Example

- When people think about focus+context views, they typically think of the *Fisheye View* (distortion)
- Introduced by George Furnas in 1981 report, more famous article is 1986 SIGCHI paper

Fisheye of Source Code

```
   1 #define DIG 40
   2 #include <stdio.h>
...4 main()
   5 {
   6       int c, i, x[DIG/4], t[DIG/4], k = DIG/4, noprint = 0;
...8       while((c=getchar()) != EOF){
   9             if(c >= '0' && c <= '9'){
..16             } else {
  17                   switch(c){
  18                         case '+':
..27                       case '-':
..38                       case 'c':
>>39                             for(i=0;i<k;i++) t[i] = x[i];
  40                             break;
  41                       case 'q':
..43                       default:
..46                   }
  47                   if(!noprint){
..57                   }
  58             }
  59             noprint = 0;
  60       }
  61 }
```

Furnas CHI '86

Figure 4. A fisheye view of the C program. Line numbers are in the left margin. "..." indicates missing lines.

Definition

- Fisheye View -

  "Provide[s] detailed views (focus) and overviews (context) without obscuring anything…The focus area (or areas) is magnified to show detail, while preserving the context, all in a single display."

  -(Shneiderman, *DTUI*, 1998)

Everyday Life Example

Kinda Fisheye - Natural 3D Perspective

Why is it called Fisheye?

- Fisheye Camera Lens

Real fisheye camera lens

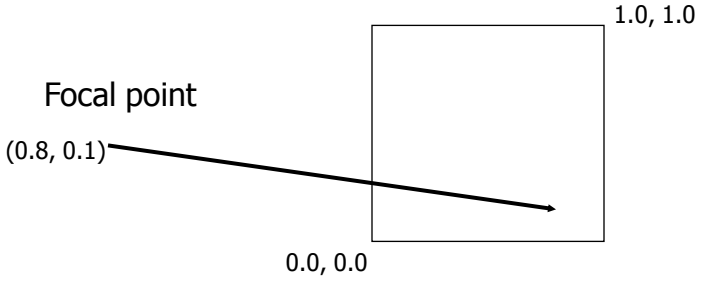
Atlanta Journal

Fisheye Terminology

- Focal point
- Level of detail
- Distance from focus
- Degree of interest function

Focal Point

- Assume that viewers focus is on some item, some coordinate, some position,...

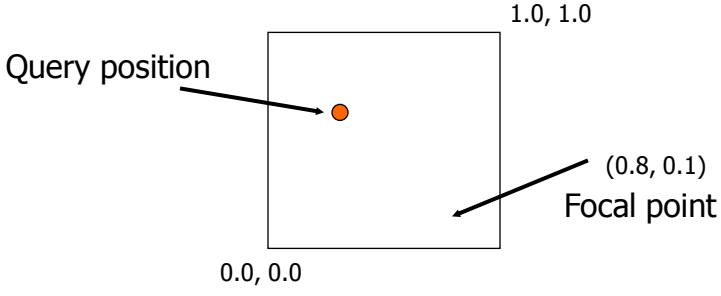


Level of Detail

- Some intrinsic value or quantity on each data element
- How important is it to you in a general sense?
- Simplest example is that all data items have same level of detail

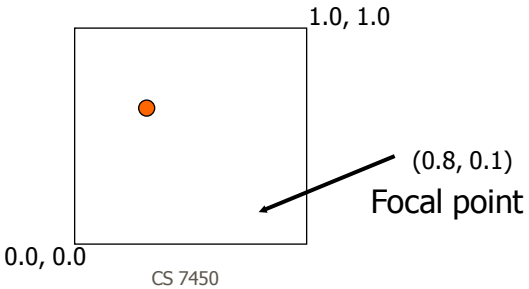
Distance from Focus

- Calculation of how far each data item is from the focal point



Degree of Interest Function

- Function that determines how items in display are rendered
  - Degree of Interest = Level of Detail - Distance from Focus
    Level of Detail / Distance from Focus



DoI Function

- Can take on various forms
  - Continuous - Smooth interpolation away from focus
  - Filtering - Past a certain point, objects disappear
  - Step - Levels or regions dictating rendering
    0<x<.3 all same, .3<x<.6 all same
  - Semantic changes - Objects change rendering at different levels

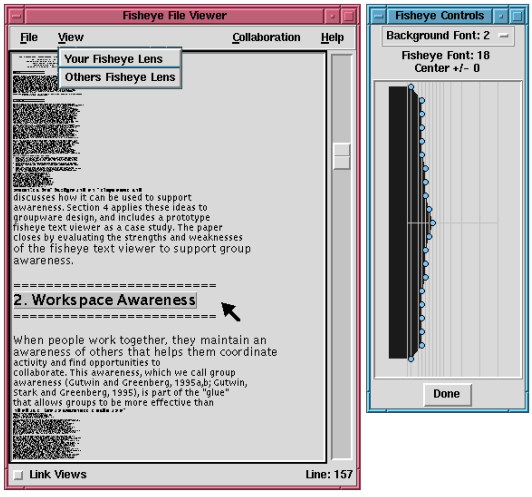
Applications

Text/program viewing

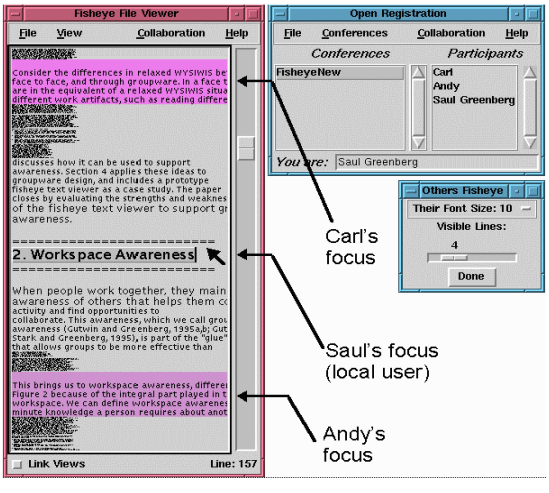
Furnas' original example

Shown here are examples from Gutwin and Greenberg

Step function



Applications



Shared text editor for CSCW

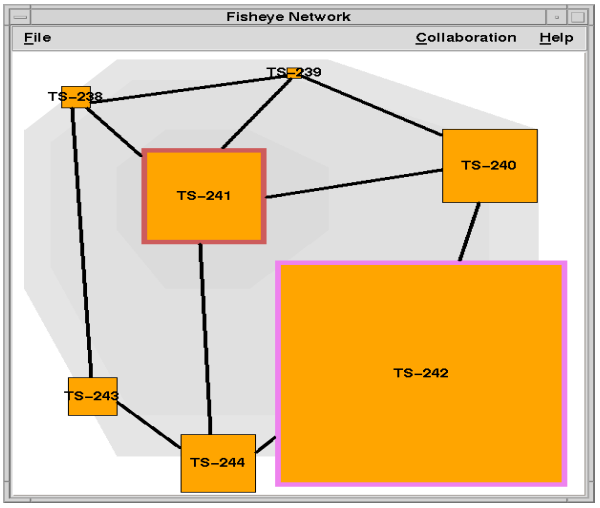
Gutwin and Greenberg HCI '96

Video

Applications

Viewing nodes in networks

Gutwin and Greenberg



Graphical Fisheye Views

- Apply fisheye techniques to 2D graph
- Experiment with a variety of distortion factors
- Interactive tool that allows user to browse display and change focus

Sarkar and Brown
CACM '94

Graphical Fisheye Views

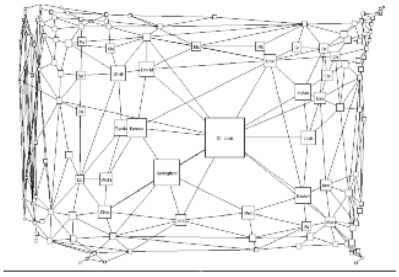


Figure 2: A fisheye view of the graph in Figure 1. The focus is on St. Louis. (The values of the fisheye parameters are $d_1 = 5$, $c = 0$, $d_2 = 0$, $VWcutoff = 0$; the meanings of these parameters are explained in Sections 4 and 6.)

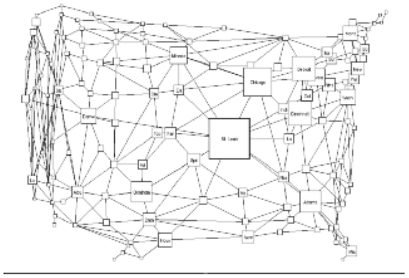
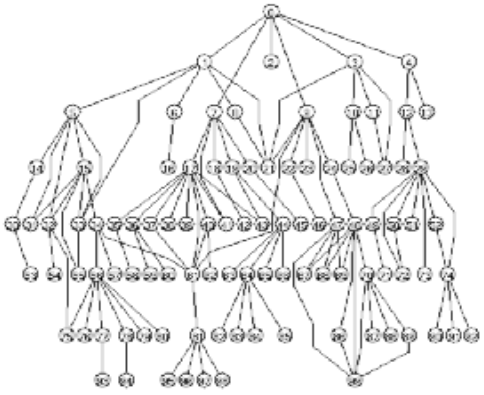


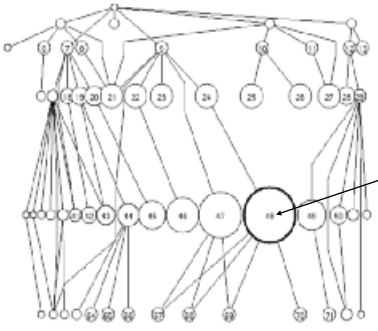
Figure 3: A fisheye view of the graph in Figure 1, with less distortion than in Figure 2. The values of the fisheye parameters are $d_1 = 2$, $c = 0.5$, $d_2 = 0.5$, $VWcutoff = 0$.

Example



Original

Example



Video

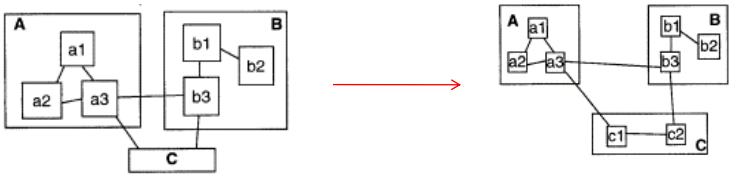
Constraining Changes

- Maybe we should limit changes in focus and context (eg, how context is represented) to make a more understandable representation…

Constraining Changes

Video

- Continuous zoom
  - Can change focal point smoothly in graph
  - Other nodes give up space

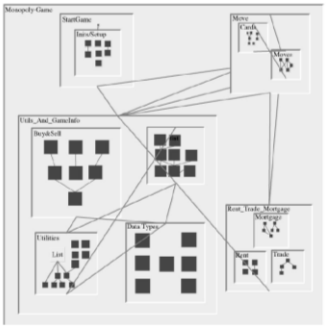


Simon Fraser Univ.

Bartram et al
UIST '95

Constraining Changes

- Constrained fisheye
  - Make transitions in focus more aesthetically pleasing and easier to track



Storey et al
JVLC '99

Simon Fraser Univ.

Alternative Methodology

- We can think of focus and degree of interest as distorting or warping the space upon which data is presented
- Such pliable surfaces can provide another form of focus+context display

Carpendale, Cowperthwaite, Fracchia
IEEE CG&A'97

Video

Carpendale and Montagnese
UIST '01

Excellent Survey

- Review and Taxonomy of Distortion-Oriented Presentation Techniques
  - Surveys systems
  - Presents unified theory

Leung and Apperly
ToCHI '94

Bifocal Display

- Interesting application of fisheye view
- View office documents
- Take items in periphery and fold back in 3-space
- Project onto front viewing screen

Spence & Apperly
BIT '82

Bifocal Display

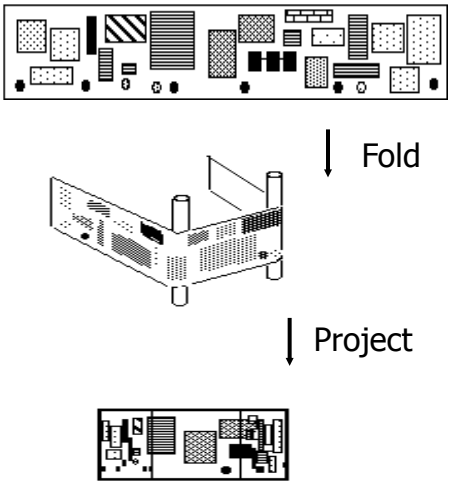
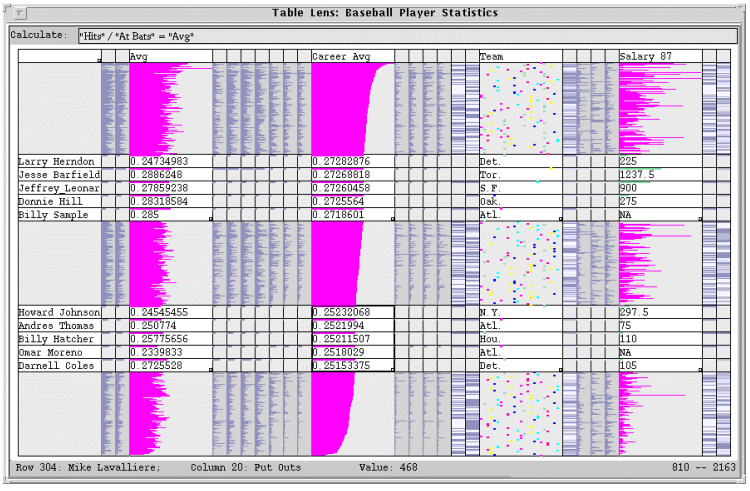


Table Lens



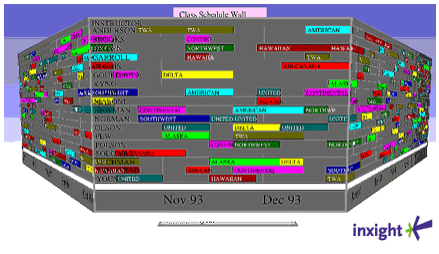
From Xerox PARC and Inxight

A bifocal display

Rao & Card CHI '94

Perspective Wall

- Computerized, automated 3D implementation of Bifocal display
- Map work charts onto diagram, x-axis is time, y-axis is project



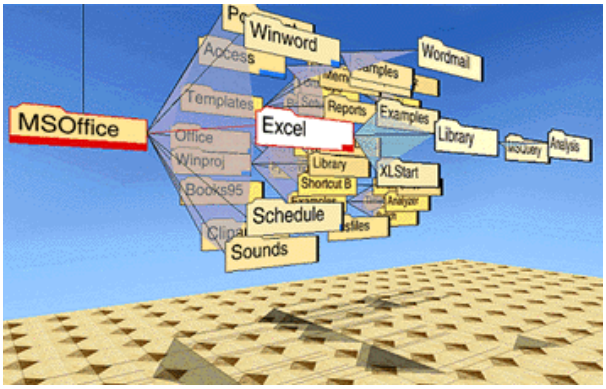
Video

Mackinlay, Robertson, Card CHI '91

Other 3D Approaches

Cone Trees

3D views of hierarchies such as file systems



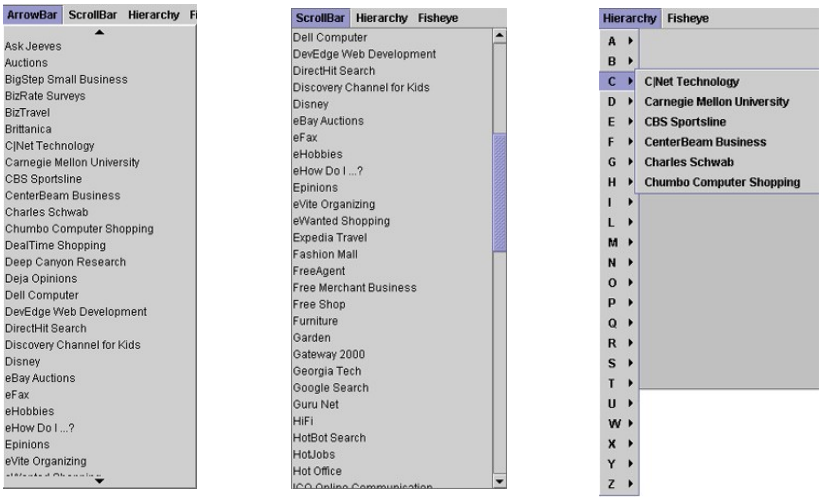
Robertson, Mackinlay, Card
CHI '91

Fisheye Application

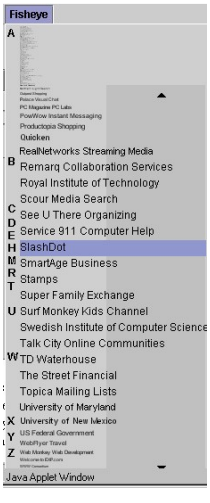
- The Problem
  - Menus have too many items
  - Especially a menu of data items (fonts)
  - Scrolling arrows & bars
  - Hierarchical groups

Bederson
UIST '00

Existing Options

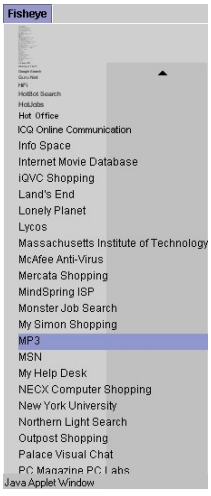


Fisheye Menus



- Dynamically change size of menu item & provide focus area around the pointer
- Items near cursor displayed at full size
- Items further away on either side are smaller
- Uses a distortion function so items will always fill menu

Focus Lock



- Problem of small movements resulting in change in focus
- Focus lock by moving to the right side of menu
- Focus region is highlighted and pointer can move up & down selecting within this area
- Moving above or below the region on the right increases the area of the region
- Controls the trade-off between number of items at full size versus those rendered smallest

Demo:
`http://www.cs.umd.edu/hcil/fisheyemenu`

Apply to Calendars

- DateLens
- Helping people better manage their calendars and appointments on a handheld display
- Uses "fisheye view"

Bederson et al
ACM ToCHI '04

Particulars

- Who – Everyday people
- Problem – How to show a potentially large amount of appointment information in a small number of screen pixels (and allow flexibility for different tasks)
- Data – Set of appointments

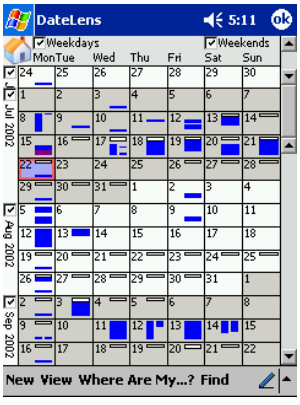
Premise

- At different points in time, you want different perspective on your appts.
  - See how my month looks
  - What's happening later this week
  - Am I double-booked this afternoon

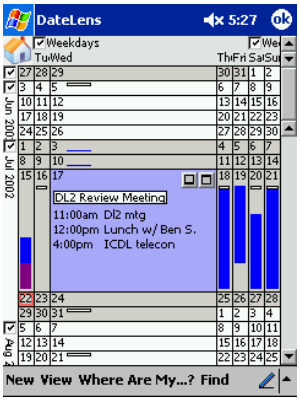
Technique

- Adopts fisheye view technique
  - Focus item(s) shown in more detail while context still visible, but simplified
- Interaction is key with smooth transitions

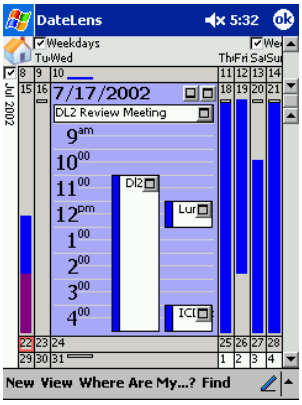
Different Perspectives



Month view



Zooming to a week



Zooming to a day

Video

Mélange

- Show 2 foci and the context in-between
- Use 3D like folding a piece of paper

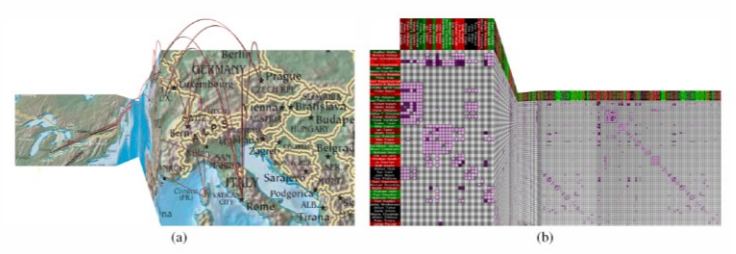


Figure 1. Examples of the Mélange technique: (a) Browsing flight routes on a world map. (b) Displaying a large matrix visualization of a network.

Video

Elmqvist et al
CHI '08

Sigma Lenses

- Use transparency and movement to vary the focus and context

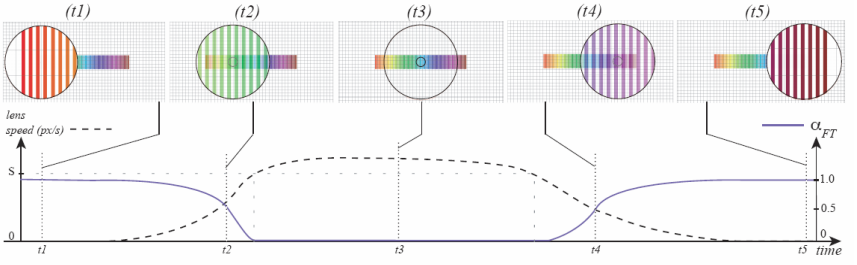


Figure 4. Speed-Coupled Blending Lens moving from left to right over time.

Video

Pietriga & Appert
CHI '08

Panacea?

- Are there any disadvantages of focus+context or fisheye techniques?

Disadvantages

- Distortion can be annoying
- Can be very difficult to implement
- Any change in focal point potentially requires recalculation of DoI for all objects and hence re-rendering of all objects -> Expensive!

Nice Review

A Review of Overview+Detail, Zooming, and Focus+Context Interfaces

ANDY COCKBURN

University of Canterbury

and

AMY KARLSON and BENJAMIN B. BEDERSON

University of Maryland

There are many interface schemes that allow users to work at, and move between, focused and contextual views of a dataset. We review and categorize these schemes according to the interface mechanisms used to separate and blend views. The four approaches are overview+detail, which uses a spatial separation between focused and contextual views; zooming, which uses a temporal separation; focus+context, which minimizes the seam between views by displaying the focus within the context; and cue-based techniques which selectively highlight or suppress items within the information space. Critical features of these categories, and empirical evidence of their success, are discussed. The aim is to provide a succinct summary of the state-of-the-art, to illuminate both successful and unsuccessful interface strategies, and to identify potentially fruitful areas for further work.

Categories and Subject Descriptors: D.2.2 [**Software Engineering**]: Design Tools and Techniques—*User interfaces*; H.5.2 [**Information Interfaces and Presentation**]: User Interfaces—*Graphical user interfaces (GUI)*

General Terms: Human Factors

Additional Key Words and Phrases: Information display, information visualization, focus+context, overview+detail, zoomable user interfaces, fisheye views, review paper

ACM Reference Format:

Cockburn, A., Karlson, A., and Bederson, B. B. 2008. A review of overview+detail, zooming, and focus+context interfaces. ACM Comput. Surv. 41, 1, Article 2 (December 2008), 31 pages DOI = 10.1145/1456650.1456652 http://doi.acm.org/10.1145/1456650.1456652

1. INTRODUCTION

In most computer applications, users need to interact with more information and with more interface components than can be conveniently displayed at one time on a single

ACM Computing Surveys '08

HW 6

- Due Monday
  - Bring 2 hardcopies

Project Advice

- Don't neglect it now
  - Make consistent progress

Upcoming

- Text & Documents 1
  - Reading:
    Viegas & Wattenberg '08
- Text & Documents 2
  - Reading:
    Keim & Oelke '07

References

- Spence and CMS books
- All referred to articles
- S. Meier, Civilization II. MicroProse:1998 http://www.civ2.com
- Demonstration maps generated at MapQuest, http://www.mapquest.com
- Shneiderman, B. *Designing the User Interface,* 1998
- http://www.csi.uottawa.ca/ordal/papers/sander/main.html
- http://www.cpsc.ucalgary.ca/grouplab/papers/1996/96-Fisheye.GI/gi96_fisheye.html